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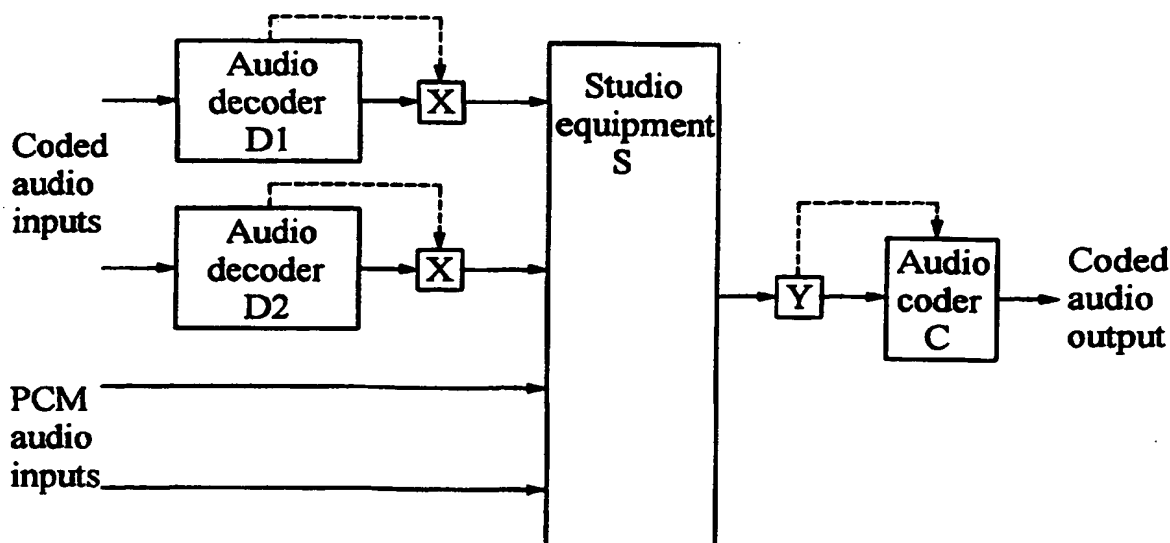
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(54) Title: AUDIO COMPRESSION**(57) Abstract**

An auxiliary data signal is derived from a received compression encoded audio signal during decoding of the signal and communicated with the decoded audio signal for use in re-encoding the signal. The auxiliary data signal may be communicated integrally with the audio signal, for example in the least significant bits, or may follow a different path. The provision of the auxiliary data signal may enable more transparent decoding and re-coding processes to take place, by allowing the coding decision to match the coding decisions originally used; this can alleviate problems with quality reduction arising from cascaded decoding and re-coding processes.

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AUDIO COMPRESSION

This invention relates to compressed, that is to say data-reduced or bit-rate reduced, digital audio signals.

5 The invention is applicable to a wide range of digital audio compression techniques; an important example is the so-called "MPEG Audio" coding, defined in ISO/IEC standards IS 11172-3 and IS 13818-3.

 In digital broadcasting, certain operations can be performed only on decoded audio signals. There is accordingly a requirement for compression
10 decoding and re-encoding in the studio environment. It is of course desirable that these cascaded decoding and re-encoding processes should involve minimal reduction in quality. Studio operations such as mixing may be conducted on a digital PCM signal, although sometimes there will be a requirement for conversion of the PCM signal to analogue form. In the
15 discussions that follow, attention will be focused on the use of a decoded audio signal in PCM format although it should be remembered that the invention also encompasses the use of decoded analogue signals in analogue form. It will further be appreciated that whilst the digital broadcasting studio environment conveniently exemplifies the present
20 invention, the invention is applicable to other uses of compressed audio signals.

 It is an object of the present invention, in one aspect, to provide improved digital audio signal processing which enables re-encoding of a compression decoded audio signal with minimal reduction in quality

25 Accordingly, the present invention consists in one aspect in a method of audio signal processing, comprising the steps of receiving a compression encoded audio signal; compression decoding the encoded audio signal; deriving an auxiliary data signal; communicating the auxiliary data signal with the decoded audio signal and re-encoding the decoded audio signal utilising information from the auxiliary data signal.

 Preferably, the auxiliary data signal comprises essentially the encoded audio signal.

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In one form of the invention, the auxiliary data signal is combined with the decoded audio signal for communication along the same signal path as the decoded audio signal.

The invention will now be described by way of example with reference
5 to the accompanying drawings in which:-

Fig. 1 is a block diagram of a digital broadcasting studio installation utilising an embodiment of the present invention;

Fig. 2 is a block diagram of similar form illustrating a second embodiment of the present invention; and

10 Fig. 3 is a more detailed block diagram of the operation of the audio decoder (D1) and insertion unit (X) of Fig. 1 when a parity based system is employed for carrying the auxiliary data.

Referring to Fig. 1, a coded audio bit-stream enters the decoder (D1) at the top left and the decoder produces a linear PCM audio signal, typically
15 in the form of an ITU-R Rec. 647 ("AES/EBU") bitstream, although other forms of PCM signal may be used. The PCM signal is connected to the studio equipment (S) which may provide such facilities as fading, mixing or switching. This connection is made via an insertion unit (X) which combines the auxiliary data signal with the PCM audio signal. Other audio sources are
20 connected to the studio equipment; these are in the form of PCM signals, but some or all of them may previously have been coded, and those decoded locally may be accompanied by auxiliary data signals (e.g. the PCM signal from Decoder D2). The output of the studio equipment is applied to the input of the coder (C) via a signal splitter unit (Y) which
25 separates the auxiliary data from the PCM signal. The output of the coder is a coded (i.e. digitally compressed) audio signal. In Fig. 1, the PCM signal path is represented by the solid line connecting the decoder and coder via the studio equipment. If just a PCM signal arrives at the coder (i.e. the auxiliary data signal is not present) the latter has to perform an independent
30 re-coding process. This introduces impairments in the form of coding artifacts into the signal (in the case of a PCM signal which has previously been coded, but without the auxiliary signal, these artifacts are additional to

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those present as the result of the earlier coding).

In the example of an MPEG audio signal, the most important information to carry with the signal are the positions of the coded audio frame boundaries. These frames are 24ms long when the sampling
5 frequency is 48 kHz.

The build up of impairments can be completely eliminated by avoiding decoding and re-coding wherever possible. For example, if enough of the original coded audio signal is conveyed to the coder, as the auxiliary data signal, the coded audio signal can be reconstituted and substituted for the
10 decoded and re-coded signal. This would require that the studio equipment pass the PCM signal transparently, and that the coded bitstreams to be switched or mixed are frame aligned, or can be brought into frame alignment. Frame aligning can give rise to problems with audio/visual synchronisation ("lip sync") in applications such as television where the video
15 is associated with the audio.

Alternatively, if the auxiliary data signal indicates to the coder the positions in the PCM bitstream of the frame boundaries of the original coded signal, it is possible to minimise any impairment introduced on re-coding if the original groups of audio samples which formed blocks of coded data
20 (e.g. sub-band filter blocks or blocks of samples with the same scale factor) are kept together to form equivalent blocks in the re-coded signal. This does not require frame alignment of coded bitstreams within the studio area, but it does require alignment of the appropriate data blocks within the bitstreams. Such alignment can be effected by the introduction of relatively
25 short delays, which do not significantly affect audio/video synchronisation. Further reductions in the impairment on re-coding may be made if information on the quantisation of the audio in the coded bitstream is conveyed to the coder (C).

A further possibility is to move frame boundaries in the incoming
30 coded bitstreams, whilst preserving the original blocks of coded data, to bring the frames closer to alignment. Relatively short delays can then be used to effect frame alignment by "fine tuning" the timing of the signals.

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Frame aligning the coded bitstreams in this way, at a point where the entire incoming coded audio signal is available will minimize further impairment of the audio, and re-coding will take place with the repositioned frame boundaries.

5 If the frame boundaries are repositioned in such a way as to preserve the original block of samples with the same scale factor, only a partial decoding operation is needed. This technique is particularly suited to the editing of bit-rate reduced digital signals because full decoding and re-encoding can be eliminated.

10 In the case where the studio is receiving MPEG audio coded signals in the form of packetised elementary streams (PES), buffer stores in the decoders are used to ensure that the audio signals are correctly timed to a local clock and (if appropriate) to associated video signals, using a programme clock reference (PCR) and presentation time stamps (PTS)
15 within signals. The relatively small adjustments to signal timing needed to align blocks within coded bitstreams entering the studio with the blocks formed by the re-encoding process in the coder (C) may be made either by making some adjustment to the timing in the decoders (D1, D2 etc.) or by introducing delays into the PCM signal paths.

20 In the arrangement of Fig. 1, the auxiliary data takes the same path as the PCM signal through the studio equipment, and is combined with the PCM audio in such a way that it has the minimal effect upon the audio. It is routed with the audio, and if the path is not transparent (e.g. because of fading or mixing) the modification of the auxiliary signal is detected in the
25 coder, and re-coding of the audio proceeds independently of the auxiliary signal. If the path is transparent, the unmodified auxiliary signal facilitates the substitution of the re-coded PCM signal by the original coded signal, or re-coding with the data blocks of the re-coded signal reproducing the blocks of the original signal as closely as possible, as described above. The dotted
30 line of Fig. 1. represents the path taken by the auxiliary data.

Any modification of the signal and associated auxiliary data is detected by appropriate examination of the auxiliary data. For example, the

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auxiliary data may be accompanied by error-detecting cyclic redundancy check bits associated with the auxiliary data for each coded audio frame.

Audio signals which have not previously been coded will not be accompanied by any auxiliary data and will be impaired by the coding artifacts introduced by first-time coding when coded by the coder (C).
5 Signals which have previously been coded but for which no auxiliary data is available will be impaired by additional coding artifacts when re-coded by the coder (C).

Although, as explained, the auxiliary data signal can be
10 communicated with the decoded audio signal in any of a number of ways, for ease of understanding, a preferred manner of implementing this will now be described with reference to Fig. 3.

Referring to Fig. 3, the decoder D1 comprises a bitstream interpreter
10 which is arranged to receive a compression encoded audio signal and to interpret it to obtain sample values and coding information, for example, in the case of MPEG-2 audio, bit allocation, scale factors and header information. From this information, a decoded sample is constructed by sample reconstruction element 12, here shown producing a 16 bit sample,
15 but other sample sizes may be employed (either less, e.g. 8 bits, or more; typically for studio applications where high quality is required, 20 or 24 bits may be used). The information concerning the coding is passed to a frame
20 formatting element 14 which combines the information into a data stream of a defined format, to produce the auxiliary data signal. Not shown in the Figure, additional source(s) of data may be present, and this additional data
25 may be formatted and carried together with the coding information. It is to be noted that, apart from the formatting of the auxiliary data, the functions of the decoder may be entirely conventional. The precise arrangement of the auxiliary data is not critical; any convenient format that allows the required information to be extracted may be chosen.

30 The decoded data stream is passed as 16 bit data to the insertion unit (X) which discards the least significant bit, and passes the remaining bits (upper 15 in this case) to a parity calculator 20. The results of the parity

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calculation are combined with a single data bit to be coded from the auxiliary data stream in parity encoder 22 to recreate a 16 bit wide data word in which the parity of the word encodes a data bit of the auxiliary data signal, odd for one, even for zero (or vice versa). The resulting (in this case 16 bit) data word may be framed and transmitted serially according to any desired system, as if it were a "genuine" audio sample. Thus, transmitting the data signal automatically achieves communication of the auxiliary data signal with the decoded audio signal.

The use of parity-based encoding is not essential; for example, the data to be sent could be simply sent as the least significant bit of the audio data.

It will be appreciated that the signal splitter unit Y requires complementary apparatus. In the example of parity based encoding, the sample data can simply be passed unchanged by the splitter Y (or the least significant bit can be altered – this makes little difference as the least significant bit no longer carries audio information) and the auxiliary data provided as the output of a parity checking device operating on the entire data word. The auxiliary data can then be supplied to a coder for use in re-coding the decoded signal, for example by using similar quantisation levels.

The auxiliary data signal need not be communicated directly with the decoded audio data, as in the above example, but may be conveyed over a separate path, as will now be described with reference to Fig. 2.

Referring to Fig. 2, the PCM audio signal takes the same path through the studio equipment from the decoder (D1) to the coder (C) via the studio equipment (S). However, in this arrangement, the auxiliary data signal is not combined with the PCM audio but is routed separately. This arrangement has the advantage that the auxiliary data is not combined with the PCM audio, and there is no risk of audible changes to the signal as a result. This might be important, for example, if the studio equipment has only a limited resolution in terms of the audio sample word-length. Furthermore, the auxiliary data is not modified by fading or mixing. There are disadvantages in that the auxiliary signal needs to be delayed to keep it

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time-aligned with the PCM audio passing through the studio equipment (5), and switching is necessary in the auxiliary data path so that the correct auxiliary data is always presented to the coder (C) with the associated PCM signal. As in the arrangement of Fig. 1, the coder needs to perform re-

5 coding independently of the auxiliary signal at times when the path through the studio equipment (S) is not transparent. One way of ensuring that this happens is for the switch (R) which routes the auxiliary signals the coder to suppress all such signals when independent re-coding is necessary.

Another way would be to add a subsidiary auxiliary data signal to the audio

10 passing through the studio equipment (S) which would enable detection of non-transparent processing. This might be, for example, a known pseudorandom binary sequence (prbs) or some form of cyclic redundancy check data on some or all of the audio data.

In Fig. 2, the delay (T) required in the auxiliary data path should be

15 constant, and may be determined by means of suitable tests. However, incoming MPEG audio coded bitstreams in PES form contain PTS, as mentioned previously, and PCM audio signals can carry time information (e.g. the time codes in the ITU-R Rec. 647 signal) which may comprise, or be derived from, the incoming PTS. If the auxiliary signal contains the same

20 information, or the PTS itself, the initial setting of the delay (T) and the subsequent verification of the amount of delay may be performed automatically.

Examples of signals that could comprise the auxiliary data are:

1. The coded audio signal at the input to the decoder (D1, D2, etc.). This contains not only audio-related data and the PTS but also
- 25 certain auxiliary information such as programme-associated data (PAD), which may need to be copied into the coded signal at the output from the studio area, and error protection. Depending upon the circumstances, such a signal would enable the coder (C) to
- 30 substitute the original coded signal for the re-coded PCM signal, or to re-code the PCM signal with blocks of audio data resembling closely

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the blocks within the original coded signal, as described above.

Conveying the coded audio signal to the coder provides the widest range of options for re-coding with minimal additional impairment of the audio.

- 5 2. The coded audio samples at the input to the decoder minus the quantised audio samples (which can be re-created identically from the PCM audio signal). This is a signal in which the positions of the frame boundaries of the original coded signal are indicated relative to the linear audio samples in the PCM signal, and from which the
- 10 positions of the blocks of data within the frames may be deduced, together with information on the allocation of bits to the various components of the coded signal (sometimes known as "bit-allocation data"), scale factors, block lengths (in coding schemes where, this is relevant), the PTS, and any other data relevant to the coding system
- 15 in use.

3. A signal similar to that described in "2" above, but containing a subset of the information described (e.g. just the positions of the frame boundaries).

Ways in which the auxiliary data signal might be transported with the

20 PCM audio are:

1. In the auxiliary sample bits of the ITU-R Rec. 647 bitstream. At the studio standard sampling frequency of 48 kHz, a total bit rate of 384 kbit/s is available in the auxiliary sample bits of both "X" and "Y" subframes. This method is ideal for conveying the auxiliary data
- 25 between different items of equipment but there is some uncertainty concerning the way in which studio equipment might treat these auxiliary sample bits. For example, the studio equipment may not route these bits through to the output with the PCM audio, or it may

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not delay these bits by the same amount as the PCM audio. In either case, some modification of the studio equipment, or of the environment around it, may be necessary.

2. In the least significant bits (l.s.b.) of the PCM audio sample words of the ITU-R Rec. 647 bitstream. The bits can be inserted into active audio or may be additional bits. Depending upon the resolution of the studio equipment these may be the same as the auxiliary sample bits (these are the l.s.b if the Rec. 647 signal is configured to carry 24-bit audio sample words) or the least significant bits within the part of the subframe reserved for 20-bit audio sample words (these are the same bits that carry the 20 most significant bits of 24-bit sample words). As shown in the example illustrated with reference to Fig. 3, the data can be carried as the least significant bit of 16 bit audio. Carrying the auxiliary data in the l.s.b. of the audio sample words overcomes the problems of routing within the studio equipment and care will be taken to ensure that the auxiliary data signal is inaudible. The studio equipment needs to be transparent to audio sample words of at least 20 bits. If necessary, the audibility of the auxiliary data signal could be reduced by scrambling (e.g. by the modulo-2 addition of a pseudorandom binary sequence, or the use of a self-synchronising scrambler). Alternatively, it could be removed altogether by truncating the audio sample words to the appropriate length (i.e. to exclude the auxiliary data).

3. In the user data bits of the ITU-R Rec. 647 bitstream. Taking the user data bits from both "X" and "Y" subframes provides a channel with a bit rate of only 96 kbit/s. In many applications this is unlikely to be sufficient to carry the complete coded audio signal. It would be sufficient to signal the positions of frame boundaries, and to carry some other information extracted from the coded audio. With this method there is uncertainty concerning the way in which studio

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equipment might treat the user data.

4. In the upper part of the audio spectrum, at frequencies higher than those of the audible components of the signal. For this purpose, the PCM audio signal would be low-pass filtered, and the coded auxiliary data signal added above the passband occupied by the audible signal. A particularly ingenious way of doing this, when the studio area is receiving MPEG audio coded signals, would be to use an MPEG analysis subband filterbank with the reciprocal synthesis filterbank at the insertion units (X) in Fig. 1. At 48 kHz sampling frequency, the audio passband extends almost up to 24 kHz. In MPEG audio coding this passband is divided into 32 equally-spaced subbands, each with a bandwidth of 750 Hz. The upper five subbands are not used, and the audio is thus effectively low-pass filtered to 20.25 KHz. The auxiliary data could be inserted into the upper subbands, and would be carried in the upper part of the spectrum of the PCM audio signal, to be extracted by another MPEG analysis filterbank at the splitter (Y) shown in Fig. 1. The PCM signal applied to the coder (C) would not need further filtering to remove the auxiliary data, as this would happen in the analysis filterbank in the coder itself.

5. The auxiliary signal might be a low-level known pseudo random binary sequence (prbs) added to the audio. The prbs would be synchronised in some way with the audio frame boundaries and may be modulated with additional data where possible. It is also possible to subtract the prbs from the data prior to final transmission or monitoring.

It has been explained that under certain circumstances it is appropriate to perform partial decoding and re-encoding. In the appended claims the terms decoding and re-encoding should be taken as including partial decoding and re-encoding, respectively.

CLAIMS

1. A method of audio signal processing, comprising the steps of receiving a compression encoded audio signal; compression decoding the encoded audio signal; deriving an auxiliary data signal; communicating the
5 auxiliary data signal with the decoded audio signal and re-encoding the decoded audio signal utilising information from the auxiliary data signal.
2. A method according to Claim 1, wherein the auxiliary data signal comprises essentially the encoded audio signal.
3. A method according to Claim 2, wherein the auxiliary data signal
10 comprises audio-related data from the encoded audio signal.
4. A method according to Claim 3, wherein the auxiliary data signal comprises time information from the encoded audio signal.
5. A method according to Claim 4, wherein the auxiliary data signal further comprises ancillary information, such as program-associated data,
15 from the encoded audio signal.
6. A method of audio signal processing, comprising the steps of receiving a compression encoded audio signal; compression decoding the encoded audio signal; deriving an auxiliary data signal indicative of the analysis and quantisation employed for the encoded audio signal;
20 communicating the auxiliary data signal with the decoded audio signal and re-encoding the decoded audio signal utilising information from the auxiliary data signal such that the re-encoded audio signal employs the same analysis and quantisation as the encoded audio signal.
7. A method according to Claim 6, wherein the analysis comprises
25 application of sub-band filter bank.

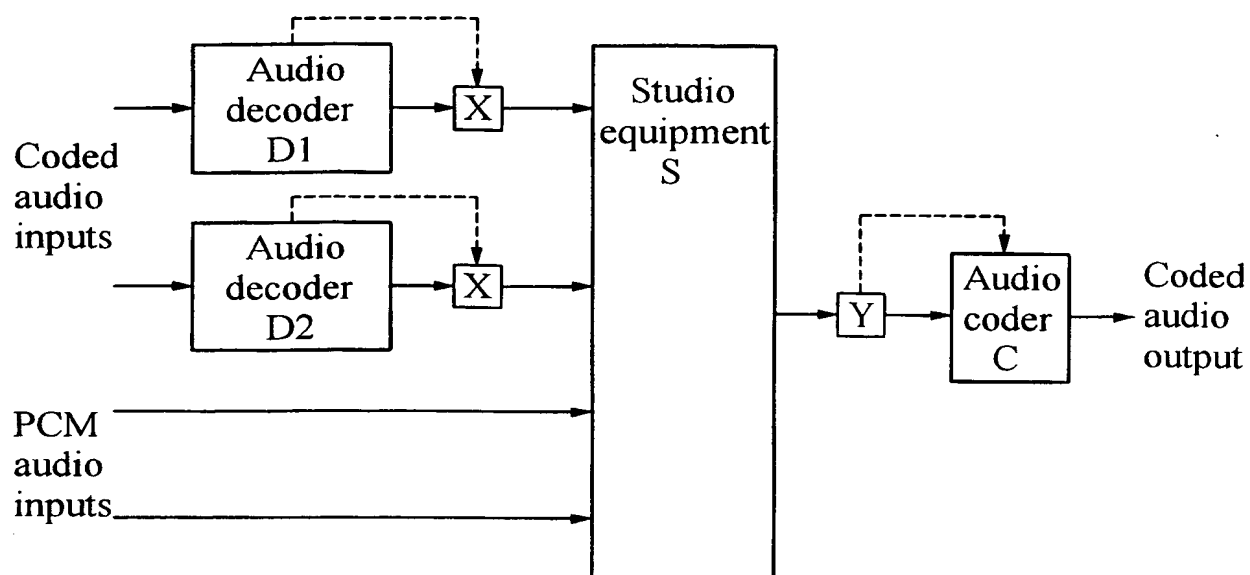
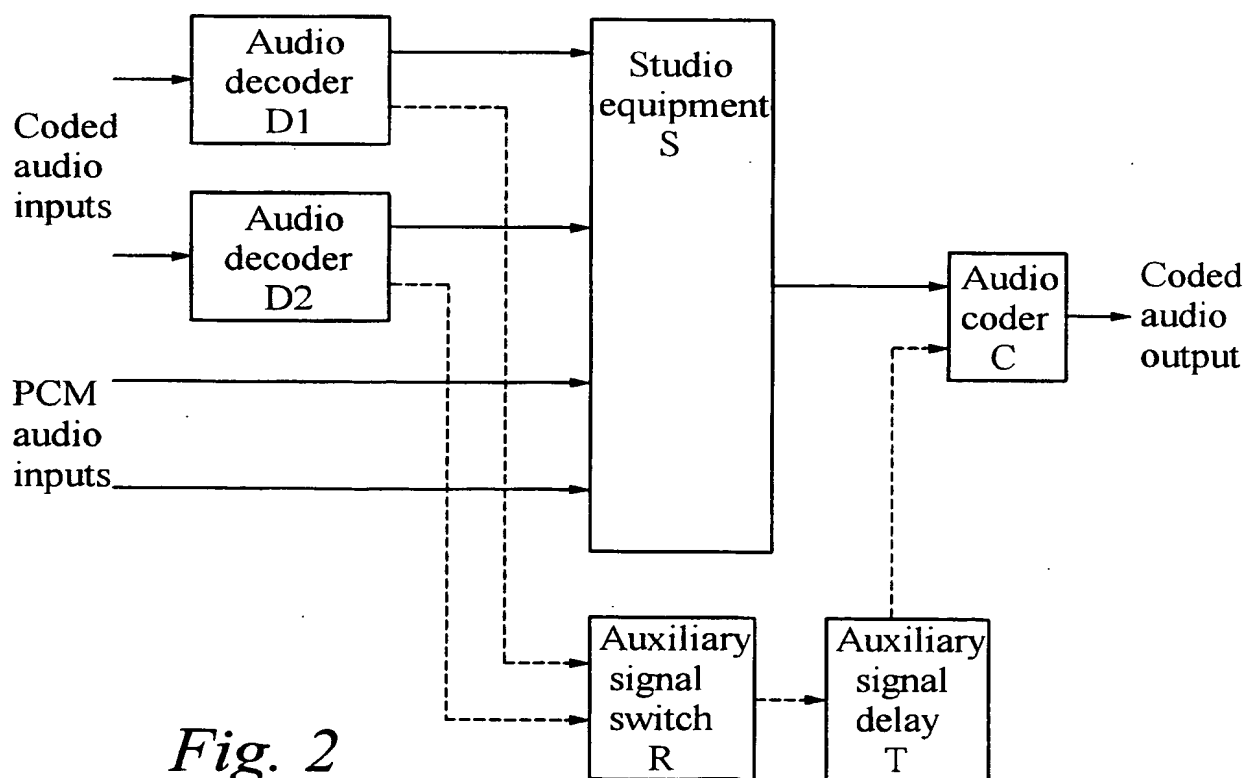
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8. A method according to Claim 7, wherein the auxiliary data signal is indicative of the frequency analysis into sub-bands and the method of quantisation within each sub-band employed for the encoded audio signal frequency.
- 5 9. A method according to any one of the preceding claims, wherein the encoded audio signal is an MPEG audio coded signal.
- 10 10. A method according to Claim 9, wherein the auxiliary data signal contains information relating to one or more of: the position of audio frame boundaries in the audio signal; frequency sub-bands; scale factors for the sub-bands within each audio frame; bit allocation data for the audio frame.
11. A method according to any one of the preceding claims, wherein the auxiliary data signal is combined with the decoded audio signal for communication along the same signal path as the decoded audio signal.
- 15 12. A method according to Claim 11, wherein the auxiliary data signal is formatted to enable an integrity check prior to use of the auxiliary data signal in a re-encoding process, to ensure transparent communication of the auxiliary data signal along the decoded audio signal path.
- 20 13. A method according to Claim 11, wherein the auxiliary data signal is carried in the least significant bits of a digital decoded audio signal.
14. A method according to Claim 11, wherein the auxiliary data signal is carried as user data bits in a recognized digital interface format such as ITU-R Rec. 647.
- 25 15. A method according to Claim 11, wherein the auxiliary data signal is carried in the upper part of the audio spectrum.

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16. A method according to Claim 15, wherein the auxiliary data signal is carried in higher frequencies associated with sub-bands unused in the compression encoding.
17. A method according to Claim 16, in which MPEG audio coding is employed, wherein a filter arrangement analogous to the MPEG analysis sub-band filter arrangement and its reciprocal, is employed for insertion of the auxiliary data signal into the decoded audio signal.
18. A method according to any one of Claims 1 to 10, wherein the auxiliary data signal is carried in a separate path to the decoded audio signal.
19. A method according to Claim 18, wherein the auxiliary data signal path is disabled in the event of processing in the decoded audio signal preventing sensible use of information from the auxiliary data signal in re-encoding.
20. A method according to Claim 19, wherein a tell-tale is added to the decoded audio signal indicative of such processing.

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*Fig. 1**Fig. 2*

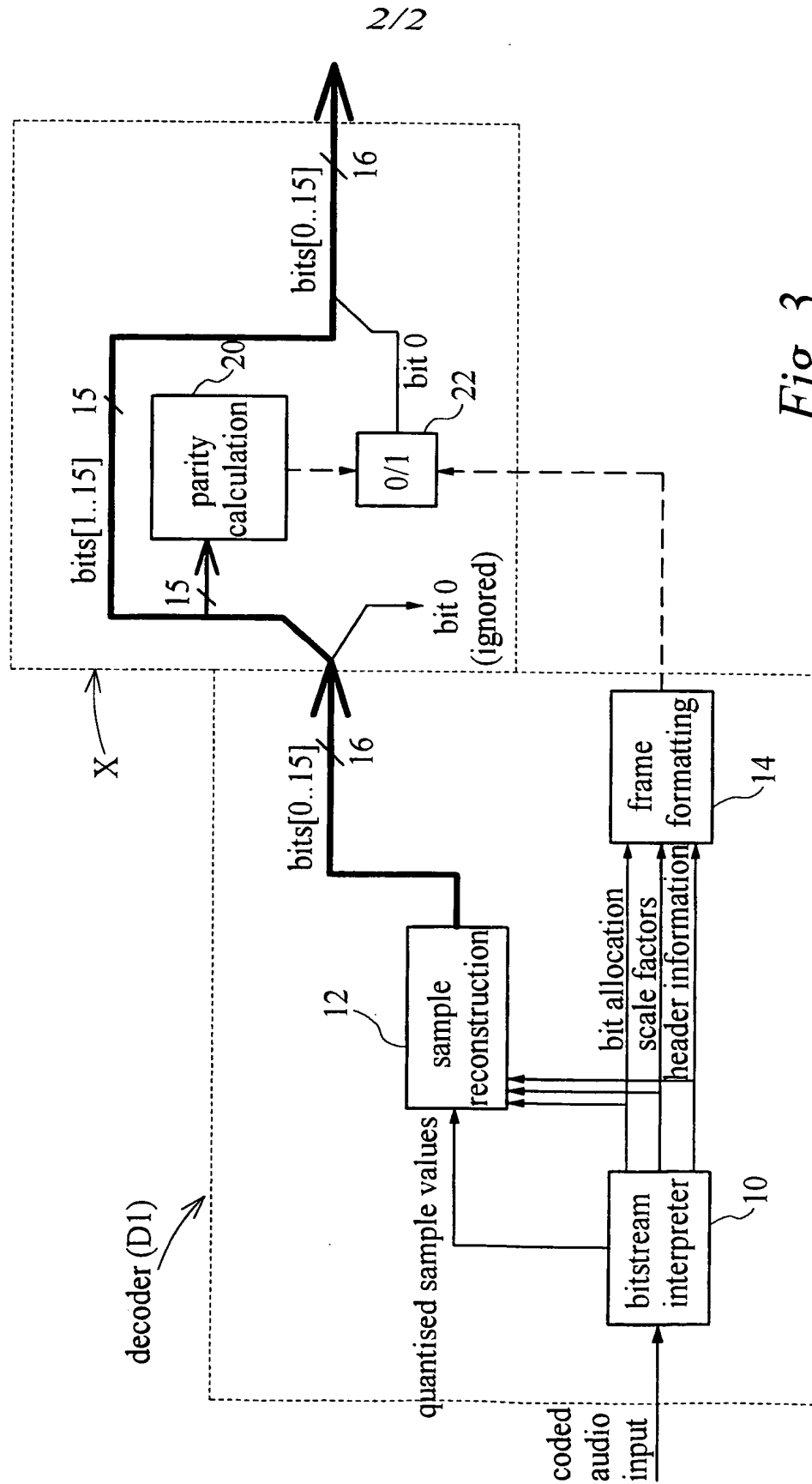


Fig. 3

CLAIMS

1. A method of audio signal processing, comprising the steps of receiving a compression encoded audio signal; compression decoding the encoded audio signal; deriving an auxiliary data signal; communicating the auxiliary data signal with the decoded audio signal and re-encoding the decoded audio signal utilising information from the auxiliary data signal.
5
2. A method according to Claim 1, wherein the auxiliary data signal comprises essentially the encoded audio signal.
3. A method according to Claim 2, wherein the auxiliary data signal
10 comprises audio-related data from the encoded audio signal.
4. A method according to Claim 3, wherein the auxiliary data signal comprises time information from the encoded audio signal.
5. A method according to Claim 4, wherein the auxiliary data signal further comprises ancillary information, such as program-associated data,
15 from the encoded audio signal.
6. A method of audio signal processing, comprising the steps of receiving a compression encoded audio signal; compression decoding the encoded audio signal; deriving an auxiliary data signal indicative of the analysis and quantisation employed for the encoded audio signal;
20 communicating the auxiliary data signal with the decoded audio signal and re-encoding the decoded audio signal utilising information from the auxiliary data signal such that the re-encoded audio signal employs the same analysis and quantisation as the encoded audio signal.
7. A method according to Claim 6, wherein the analysis comprises
25 application of sub-band filter bank.

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8. A method according to Claim 7, wherein the auxiliary data signal is indicative of the frequency analysis into sub-bands and the method of quantisation within each sub-band employed for the encoded audio signal frequency.
- 5 9. A method according to any one of the preceding claims, wherein the encoded audio signal is an MPEG audio coded signal.
- 10 10. A method according to Claim 9, wherein the auxiliary data signal contains information relating to one or more of: the position of audio frame boundaries in the audio signal; frequency sub-bands; scale factors for the sub-bands within each audio frame; bit allocation data for the audio frame.
11. A method according to any one of the preceding claims, wherein the auxiliary data signal is combined with the decoded audio signal for communication along the same signal path as the decoded audio signal.
- 15 12. A method according to Claim 11, wherein the auxiliary data signal is formatted to enable an integrity check prior to use of the auxiliary data signal in a re-encoding process, to ensure transparent communication of the auxiliary data signal along the decoded audio signal path.
- 20 13. A method according to Claim 11, wherein the auxiliary data signal is carried in the least significant bits of a digital decoded audio signal.
14. A method according to Claim 11, wherein the auxiliary data signal is carried as user data bits in a recognized digital interface format such as ITU-R Rec. 647.
- 25 15. A method according to Claim 11, wherein the auxiliary data signal is carried in the upper part of the audio spectrum.

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16. A method according to Claim 15, wherein the auxiliary data signal is carried in higher frequencies associated with sub-bands unused in the compression encoding.
- 5 17. A method according to Claim 16, in which MPEG audio coding is employed, wherein a filter arrangement analogous to the MPEG analysis sub-band filter arrangement and its reciprocal, is employed for insertion of the auxiliary data signal into the decoded audio signal.
- 10 18. A method according to any one of Claims 1 to 10, wherein the auxiliary data signal is carried in a separate path to the decoded audio signal.
19. A method according to Claim 18, wherein the auxiliary data signal path is disabled in the event of processing in the decoded audio signal preventing sensible use of information from the auxiliary data signal in re-encoding.
- 15 20. A method according to Claim 19, wherein a tell-tale is added to the decoded audio signal indicative of such processing.

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference PDG/IK/19542	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/GB98/00226	International filing date (day/month/year) 27/01/1998	Priority date (day/month/year) 27/01/1997
International Patent Classification (IPC) or national classification and IPC H04B1/66		
Applicant BRITISH BROADCASTING CORPORATION et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.



2. This REPORT consists of a total of 5 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 3 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand 13/07/1998	Date of completion of this report 30.03.99
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. (+49-89) 2399-0 Tx: 523656 epmu d Fax: (+49-89) 2399-4465	Authorized officer Phillips. S Telephone No. (+49-89) 2399 8674 

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB98/00226

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

1-10 as originally filed

Claims, No.:

1-20 as received on 19/03/1999 with letter of 19/03/1999

Drawings, sheets:

1/2,2/2 as originally filed

2. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB98/00226

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-20
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-20
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-20
	No:	Claims	

2. Citations and explanations

see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Section I

1. **Claim 1** is based on original claim 1 plus Figure 2.
Claim 6 is based on original claim 6 plus Figure 2.

Section V

1. The application relates to a method (**claim 1**) for handling a compressed audio signal.
2. None of the available prior art documents discloses deriving an auxiliary data signal relating to a compression encoded audio signal; communicating the auxiliary data signal together with the decoded audio signal and re-encoding the decoded audio signal utilising information from the auxiliary data signal.

The subject-matter of **claim 1** is therefore novel (Article 33(2) PCT).

3. Problem: How to provide audio signal handling which enables re-encoding of a compression decoded audio signal with minimal reduction in quality.
4. Solution: deriving an auxiliary data signal relating to the compression encoded audio signal; communicating the auxiliary data signal together with the decoded audio signal and re-encoding the decoded audio signal utilising information from the auxiliary data signal.

None of the available prior art documents provide any hint to do this and the particular solution is non-obvious. The utilisation of information from an auxiliary data signal in re-encoding a decoded audio signal would provide the advantage of minimising the reduction in signal quality compared to a system which did not perform this step. The particular solution is therefore considered to be inventive (Article 33(3) PCT).

5. The dependent claims add further features to the independent claim and thus also relate to novel and inventive subject matter and hence meet the requirements of Article 33(2) and (3) PCT.

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/GB98/00226

Section VII

1. The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).
2. The description is not in conformity with the claims as required by Rule 5.1(a)(iii) PCT.

Section VIII

1. **Claim 6** comprises all the features of claim 1 and is therefore not appropriately formulated as a claim dependent on the latter (Rule 6.4 PCT).
2. The following claims are unclear in the sense of Article 6 PCT for the reasons given below:
 - (a) It is not clear whether "the encoded audio signal" (**Claim 6** line 9 and **claim 10** lines 3, 4 and 5) is intended to refer to "the compression encoded audio signal" (Claim 6 line 3).
 - (b) "the audio spectrum" and "the upper part" (**claim 15** line 2) are unclear because they have not previously been disclosed in any of the claims on which claim 15 is dependent.
 - (c) "the MPEG analysis sub-band filter arrangement " (**claim 17** lines 2-3) is unclear because it has not previously been disclosed in any of the claims on which claim 17 is dependent.

CLAIMS

1. A method of audio signal handling, comprising the steps of receiving a compression encoded audio signal and compression decoding the compression encoded audio signal to produce a decoded audio signal, characterised in that the method further comprises: deriving an auxiliary data signal relating to the compression encoded audio signal; communicating the auxiliary data signal together with the decoded audio signal and re-encoding the decoded audio signal utilising information from the auxiliary data signal.
2. A method according to Claim 1, wherein the auxiliary data signal comprises all or part of the encoded audio signal.
3. A method according to Claim 2, wherein the auxiliary data signal comprises audio-related data from the encoded audio signal.
4. A method according to Claim 3, wherein the auxiliary data signal comprises time information from the encoded audio signal.
5. A method according to Claim 4, wherein the auxiliary data signal further comprises ancillary information, such as program-associated data, from the encoded audio signal.
6. A method of audio signal handling, comprising the steps of receiving a compression encoded audio signal and compression decoding the compression encoded audio signal to produce a decoded audio signal, characterised by the further steps of: deriving an auxiliary data signal indicative of the analysis and quantisation employed for the compression encoded audio signal; communicating the auxiliary data signal together with the decoded audio signal and re-encoding the decoded audio signal utilising information from the auxiliary data signal to produce a re-encoded audio signal employing the same analysis and quantisation as the encoded audio signal.

7. A method according to Claim 6, wherein the analysis comprises application of a sub-band filter bank.

8. A method according to Claim 7, wherein the auxiliary data signal is indicative of the frequency analysis into sub-bands and the method of
5 quantisation within each sub-band employed for the encoded audio signal frequency.

9. A method according to any one of the preceding claims, wherein the encoded audio signal is an MPEG audio coded signal.

10. A method according to Claim 9, wherein the auxiliary data signal
10 contains information relating to one or more of: the position of audio frame boundaries in the encoded audio signal; frequency sub-bands; scale factors for the sub-bands within each audio frame of the encoded audio signal; bit allocation data for each audio frame of the encoded audio signal.

15 11. A method according to any one of the preceding claims, wherein the auxiliary data signal is combined with the decoded audio signal for communication along a common signal path with the decoded audio signal.

12. A method according to Claim 11, wherein the auxiliary data signal is formatted to enable an integrity check prior to use of the auxiliary data signal
20 in a re-encoding process, to ensure transparent communication of the auxiliary data signal along a decoded audio signal path.

13. A method according to Claim 11, wherein the auxiliary data signal is carried in the least significant bits of a digital decoded audio signal.

14. A method according to Claim 11, wherein the auxiliary data signal is
25 carried as user data bits in a recognized digital interface format.

15. A method according to Claim 11, wherein the auxiliary data signal is carried in the upper part of the audio spectrum.

16. A method according to Claim 15, wherein the auxiliary data signal is carried in higher frequencies associated with sub-bands unused in the
5 compression encoding.

17. A method according to Claim 16, in which MPEG audio coding is employed, wherein a filter arrangement analogous to the MPEG analysis sub-band filter arrangement and its reciprocal, is employed for insertion of the auxiliary data signal into the decoded audio signal.

10 18. A method according to any one of Claims 1 to 10, wherein the auxiliary data signal is carried in a separate path to the decoded audio signal.

19. A method according to Claim 18, wherein the auxiliary data signal path is disabled in the event of processing of the decoded audio signal preventing sensible use of information from the auxiliary data signal in re-encoding.

15 20. A method according to Claim 19, wherein a tell-tale is added to the decoded audio signal indicative of such processing.

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

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London WC1X 8AL
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MATHYS & SQUIRE

01 APR 1999

REPLY DATE

DIARY ENTERED

PCT

NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL PRELIMINARY
EXAMINATION REPORT

(PCT Rule 71.1)

Date of mailing
(day/month/year)

30.03.99

Applicant's or agent's file reference

PDG/IK/19542

IMPORTANT NOTIFICATION

International application No.
PCT/GB98/00226

International filing date (day/month/year)
27/01/1998

Priority date (day/month/year)
27/01/1997

Applicant

BRITISH BROADCASTING CORPORATION et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/



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Fax: (+49-89) 2399-4465

Authorized officer

Teschauer, B


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PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference PDG/IK/19542		FOR FURTHER ACTION		See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/GB98/00226	International filing date (day/month/year) 27/01/1998	Priority date (day/month/year) 27/01/1997		
International Patent Classification (IPC) or national classification and IPC H04B1/66				
Applicant BRITISH BROADCASTING CORPORATION et al.				
<p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 5 sheets, including this cover sheet.</p> <p><input checked="" type="checkbox"/> This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of 3 sheets.</p>				
<p>3. This report contains indications relating to the following items:</p> <ul style="list-style-type: none"> I <input checked="" type="checkbox"/> Basis of the report II <input type="checkbox"/> Priority III <input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability IV <input type="checkbox"/> Lack of unity of invention V <input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement VI <input type="checkbox"/> Certain documents cited VII <input checked="" type="checkbox"/> Certain defects in the international application VIII <input checked="" type="checkbox"/> Certain observations on the international application 				
Date of submission of the demand 13/07/1998		Date of completion of this report 30.03.99		
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. (+49-89) 2399-0 Tx: 523656 epmu d Fax: (+49-89) 2399-4465		Authorized officer Phillips, S Telephone No. (+49-89) 2399 8674		



**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB98/00226

I. Basis of the report

1. This report has been drawn on the basis of *(substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.)*:

Description, pages:

1-10 as originally filed

Claims, No.:

1-20 as received on 19/03/1999 with letter of 19/03/1999

Drawings, sheets:

1/2,2/2 as originally filed

2. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB98/00226

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims 1-20
	No:	Claims
Inventive step (IS)	Yes:	Claims 1-20
	No:	Claims
Industrial applicability (IA)	Yes:	Claims 1-20
	No:	Claims

2. Citations and explanations

see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/GB98/00226

Section I

1. **Claim 1** is based on original claim 1 plus Figure 2.
Claim 6 is based on original claim 6 plus Figure 2.

Section V

1. The application relates to a method (**claim 1**) for handling a compressed audio signal.
2. None of the available prior art documents discloses deriving an auxiliary data signal relating to a compression encoded audio signal; communicating the auxiliary data signal together with the decoded audio signal and re-encoding the decoded audio signal utilising information from the auxiliary data signal.

The subject-matter of **claim 1** is therefore novel (Article 33(2) PCT).

3. Problem: How to provide audio signal handling which enables re-encoding of a compression decoded audio signal with minimal reduction in quality.
4. Solution: deriving an auxiliary data signal relating to the compression encoded audio signal; communicating the auxiliary data signal together with the decoded audio signal and re-encoding the decoded audio signal utilising information from the auxiliary data signal.

None of the available prior art documents provide any hint to do this and the particular solution is non-obvious. The utilisation of information from an auxiliary data signal in re-encoding a decoded audio signal would provide the advantage of minimising the reduction in signal quality compared to a system which did not perform this step. The particular solution is therefore considered to be inventive (Article 33(3) PCT).

5. The dependent claims add further features to the independent claim and thus also relate to novel and inventive subject matter and hence meet the requirements of Article 33(2) and (3) PCT.

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/GB98/00226

Section VII

1. The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).
2. The description is not in conformity with the claims as required by Rule 5.1(a)(iii) PCT.

Section VIII

1. **Claim 6** comprises all the features of claim 1 and is therefore not appropriately formulated as a claim dependent on the latter (Rule 6.4 PCT).
2. The following claims are unclear in the sense of Article 6 PCT for the reasons given below:
 - (a) It is not clear whether "the encoded audio signal" (**Claim 6** line 9 and **claim 10** lines 3, 4 and 5) is intended to refer to "the compression encoded audio signal" (Claim 6 line 3).
 - (b) "the audio spectrum" and "the upper part" (**claim 15** line 2) are unclear because they have not previously been disclosed in any of the claims on which claim 15 is dependent.
 - (c) "the MPEG analysis sub-band filter arrangement " (**claim 17** lines 2-3) is unclear because it has not previously been disclosed in any of the claims on which claim 17 is dependent.

CLAIMS

1. A method of audio signal handling, comprising the steps of receiving a compression encoded audio signal and compression decoding the compression encoded audio signal to produce a decoded audio signal,
5 characterised in that the method further comprises: deriving an auxiliary data signal relating to the compression encoded audio signal; communicating the auxiliary data signal together with the decoded audio signal and re-encoding the decoded audio signal utilising information from the auxiliary data signal.
2. A method according to Claim 1, wherein the auxiliary data signal
10 comprises all or part of the encoded audio signal.
3. A method according to Claim 2, wherein the auxiliary data signal comprises audio-related data from the encoded audio signal.
4. A method according to Claim 3, wherein the auxiliary data signal comprises time information from the encoded audio signal.
- 15 5. A method according to Claim 4, wherein the auxiliary data signal further comprises ancillary information, such as program-associated data, from the encoded audio signal.
6. A method of audio signal handling, comprising the steps of receiving a compression encoded audio signal and compression decoding the
20 compression encoded audio signal to produce a decoded audio signal, characterised by the further steps of: deriving an auxiliary data signal indicative of the analysis and quantisation employed for the compression encoded audio signal; communicating the auxiliary data signal together with the decoded audio signal and re-encoding the decoded audio signal utilising information
25 from the auxiliary data signal to produce a re-encoded audio signal employing the same analysis and quantisation as the encoded audio signal.

7. A method according to Claim 6, wherein the analysis comprises application of a sub-band filter bank.

8. A method according to Claim 7, wherein the auxiliary data signal is indicative of the frequency analysis into sub-bands and the method of
5 quantisation within each sub-band employed for the encoded audio signal frequency.

9. A method according to any one of the preceding claims, wherein the encoded audio signal is an MPEG audio coded signal.

10. A method according to Claim 9, wherein the auxiliary data signal
10 contains information relating to one or more of: the position of audio frame boundaries in the encoded audio signal; frequency sub-bands; scale factors for the sub-bands within each audio frame of the encoded audio signal; bit allocation data for each audio frame of the encoded audio signal.

15 11. A method according to any one of the preceding claims, wherein the auxiliary data signal is combined with the decoded audio signal for communication along a common signal path with the decoded audio signal.

12. A method according to Claim 11, wherein the auxiliary data signal is
20 formatted to enable an integrity check prior to use of the auxiliary data signal in a re-encoding process, to ensure transparent communication of the auxiliary data signal along a decoded audio signal path.

13. A method according to Claim 11, wherein the auxiliary data signal is carried in the least significant bits of a digital decoded audio signal.

14. A method according to Claim 11, wherein the auxiliary data signal is
25 carried as user data bits in a recognized digital interface format.

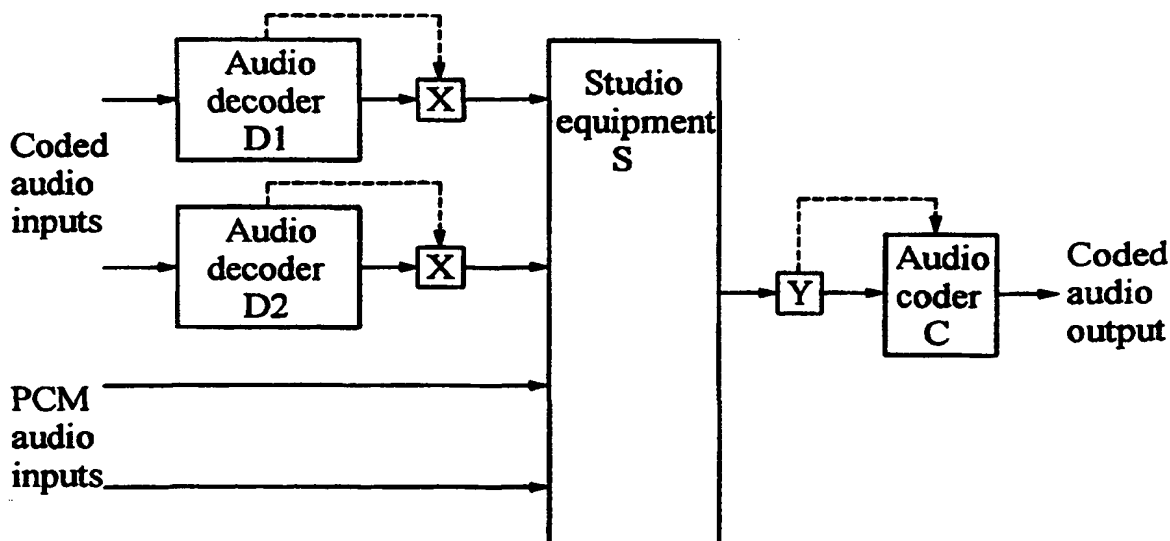
15. A method according to Claim 11, wherein the auxiliary data signal is carried in the upper part of the audio spectrum.
16. A method according to Claim 15, wherein the auxiliary data signal is carried in higher frequencies associated with sub-bands unused in the compression encoding.
17. A method according to Claim 16, in which MPEG audio coding is employed, wherein a filter arrangement analogous to the MPEG analysis sub-band filter arrangement and its reciprocal, is employed for insertion of the auxiliary data signal into the decoded audio signal.
18. A method according to any one of Claims 1 to 10, wherein the auxiliary data signal is carried in a separate path to the decoded audio signal.
19. A method according to Claim 18, wherein the auxiliary data signal path is disabled in the event of processing of the decoded audio signal preventing sensible use of information from the auxiliary data signal in re-encoding.
20. A method according to Claim 19, wherein a tell-tale is added to the decoded audio signal indicative of such processing.

PCTWORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : H04B 1/66		A3	(11) International Publication Number: WO 98/33284
			(43) International Publication Date: 30 July 1998 (30.07.98)
(21) International Application Number: PCT/GB98/00226		(81) Designated States: AU, CA, JP, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).	
(22) International Filing Date: 27 January 1998 (27.01.98)			
(30) Priority Data: 9701616.6 27 January 1997 (27.01.97) GB		Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>	
(71) Applicant (for all designated States except US): BRITISH BROADCASTING CORPORATION [GB/GB]; Broadcasting House, London W1A 1AA (GB).		(88) Date of publication of the international search report: 14 January 1999 (14.01.99)	
(72) Inventors; and (75) Inventors/Applicants (for US only): WELLS, Nicholas, Dominic [GB/GB]; 17 Wellington Road, Brighton, East Sussex BN2 3AB (GB). MASON, Andrew, James [GB/GB]; 1 Meadow Way, Reigate, Surrey RH2 8DP (GB). FLETCHER, John, Andrew [GB/GB]; 39 Holly Road, Reigate, Surrey RH2 7LU (GB). MCPARLAND, Andrew, Kevin [GB/GB]; 3 Kingsley Road, Horley, Surrey RH6 8HP (GB).			
(74) Agents: KAZI, Ilya et al.; Mathys & Squire, 100 Grays Inn Road, London WC1X 8AL (GB).			

(54) Title: AUDIO COMPRESSION



(57) Abstract

An auxiliary data signal is derived from a received compression encoded audio signal during decoding of the signal and communicated with the decoded audio signal for use in re-encoding the signal. The auxiliary data signal may be communicated integrally with the audio signal, for example in the least significant bits, or may follow a different path. The provision of the auxiliary data signal may enable more transparent decoding and re-coding processes to take place, by allowing the coding decision to match the coding decisions originally used; this can alleviate problems with quality reduction arising from cascaded decoding and re-coding processes.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 98/00226

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 H04B1/66

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 H04B H04H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 570 363 A (HOLM ROBERT E) 29 October 1996 see column 1, line 50 - column 1, line 64 ---	1,6
A	US 5 451 954 A (DAVIS MARK F ET AL) 19 September 1995 see abstract; figures 1,2 see column 7, line 35 - column 8, line 57 ---	1,6,11
A	"ERROR CORRECTION IN A HIDDEN CHANNEL TRANSMISSION SYSTEM" RESEARCH DISCLOSURE, no. 375, July 1995, page 498/499 XP000524820 see the whole document ---	1,6,11
A	EP 0 423 050 A (FRANCE ETAT) 17 April 1991 see abstract; figure 1 ---	1,6,10
-/--		

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

4 November 1998

Date of mailing of the international search report

16/11/1998

Name and mailing address of the ISA

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Fax: (+31-70) 340-3016

Authorized officer

Van Roost, L

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte. Application No

PCT/GB 98/00226

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5570363	A	29-10-1996	NONE	
US 5451954	A	19-09-1995	NONE	
EP 0423050	A	17-04-1991	FR 2653280 A	19-04-1991
			DE 69015105 D	26-01-1995
			DE 69015105 T	20-07-1995
			JP 3167927 A	19-07-1991
			US 5185800 A	09-02-1993
EP 0640909	A	01-03-1995	US 5568495 A	22-10-1996